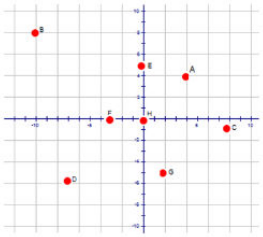
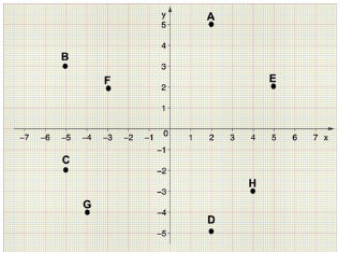
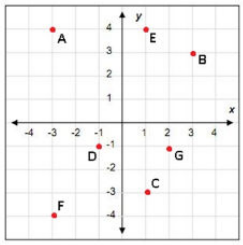
Actividad 1.9 (Landmarks)

2. **Implementar** el código requerido para generar el seguimiento de los siguientes waypoints (puntos de referencia), ajustando el tiempo de muestreo: **"sampleTime"**, vector de tiempo: **"tVec"**, pose inicial: **"initPose"**, y los waypoints: **"waypoints"**







Para este segundo punto, genere el seguimiento de los waypoints para tres incisos, primero obtuve los puntos de referencia y luego de manera heuristica obtuve el tiempo de simulacion aproximado para concluir con toda la trayectoria. En estos ejercicios utilice una velocidad linal de 1 y angular de 1.5, por lo que se puede observar en las graficas como al cambiar al siguiente waypoint y si hay un giro pronunciado, da una vuelta que se desvia mucho de la trayectoria, pero esto es debido a que la velocidad angular no es la suficiente con respecto a la lineal, en este caso la angular debe ser mucho mas grande que la lineal, para que la vuelta sea muy rapida y no avance tanto al mismo tiempo.

```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:98;         % Time array

initPose = [4;4;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [4,4; -10,8; 8,-1; -7,-6; 0,5; -3,0; 2,-5; 0,0];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 1;
```

```
controller.MaxAngularVelocity = 1.5;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);

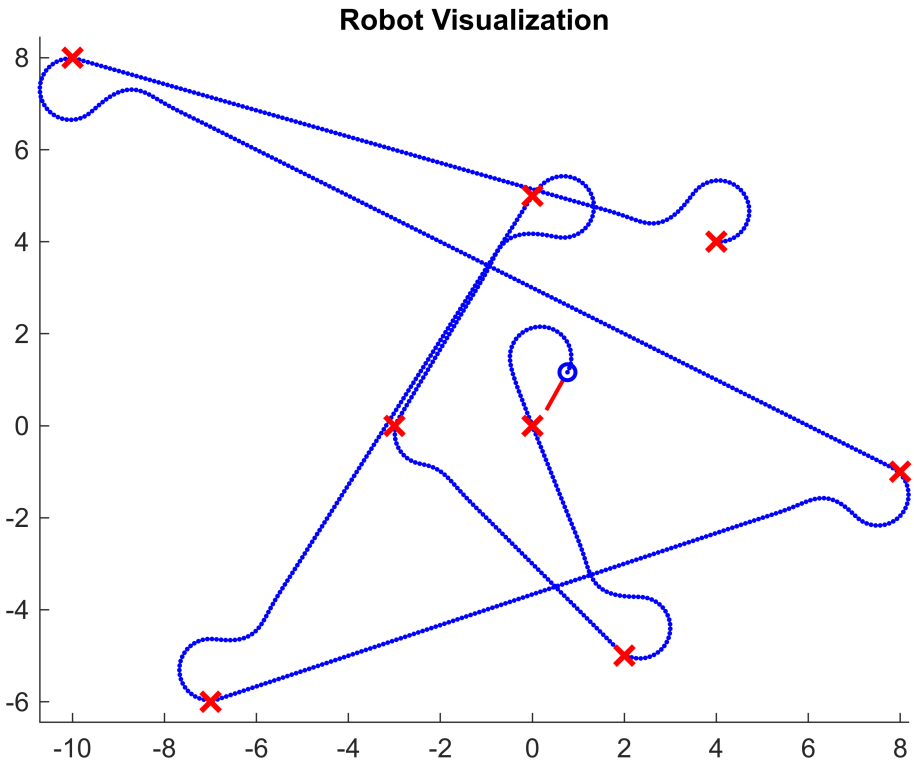

    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);

end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
will no longer be supported. Remove 'matlab.system.mixin.CustomIcon' and define corresponding System object
methods instead.
```



```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:55;         % Time array

initPose = [2;5;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [2,5; -5,3; -5,-2; 2,-5; 5,2; -3,2; -4,-4; 4,-3];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 1;
controller.MaxAngularVelocity = 1.5;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);


    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);
```

```
end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
will no longer be supported. Remove 'matlab.system.mixin.CustomIcon' and define corresponding System object
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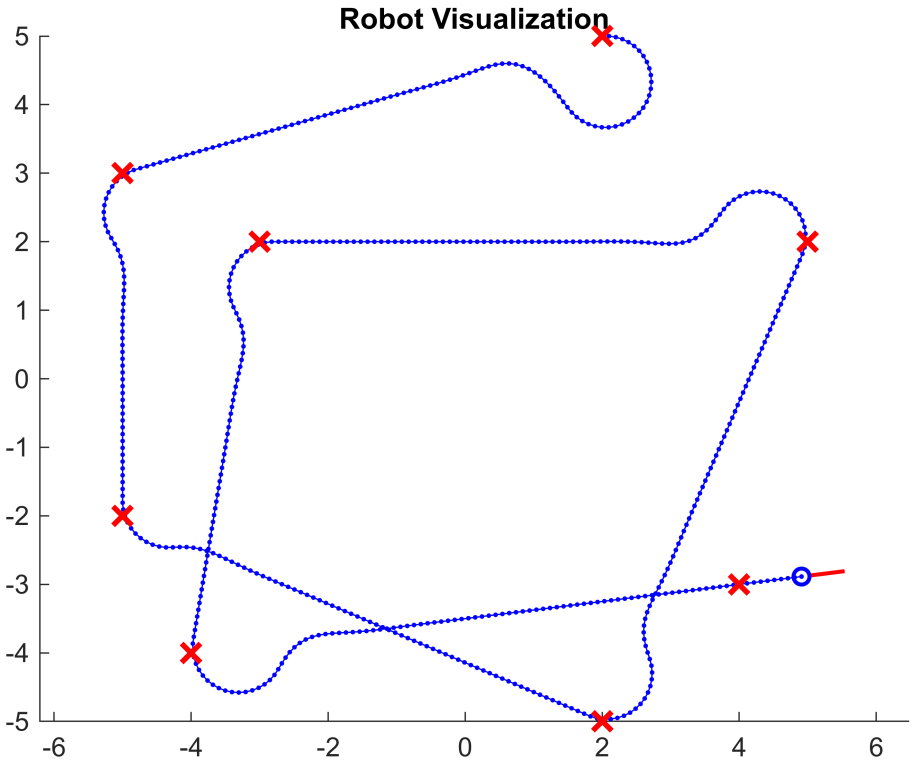
```




```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.1;               % Sample time [s]
tVec = 0:sampleTime:41;         % Time array

initPose = [-3;4;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [-3,4; 3,3; 1,-3; -1,-1; 1,4; -3,-4; 2,-1];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
```

```
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.35;
controller.DesiredLinearVelocity = 1;
controller.MaxAngularVelocity = 1.5;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);


    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);

end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
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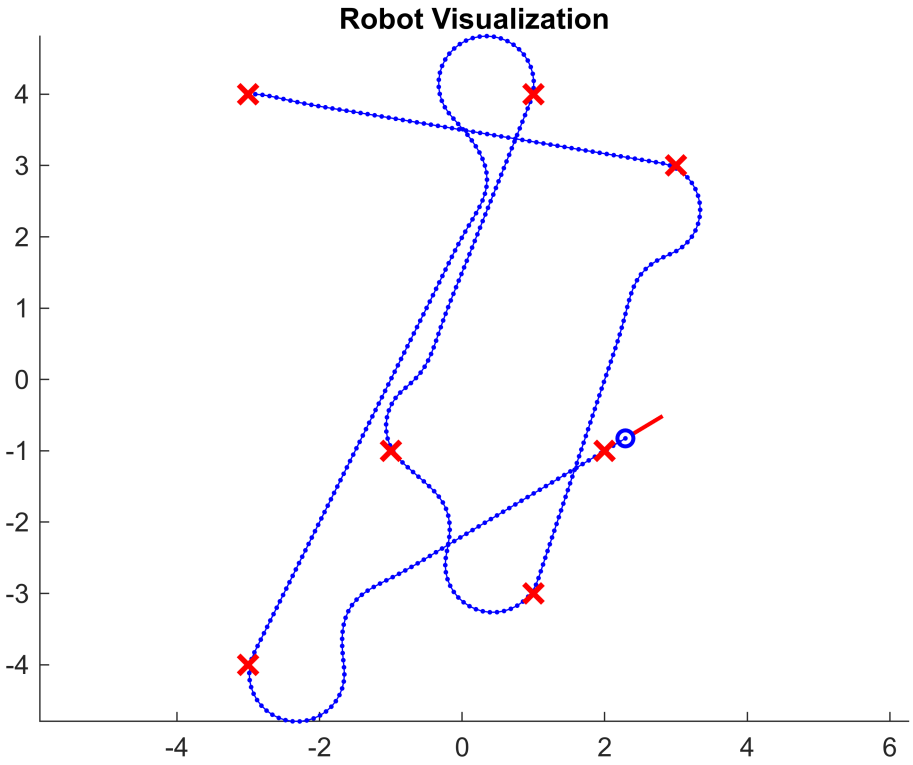
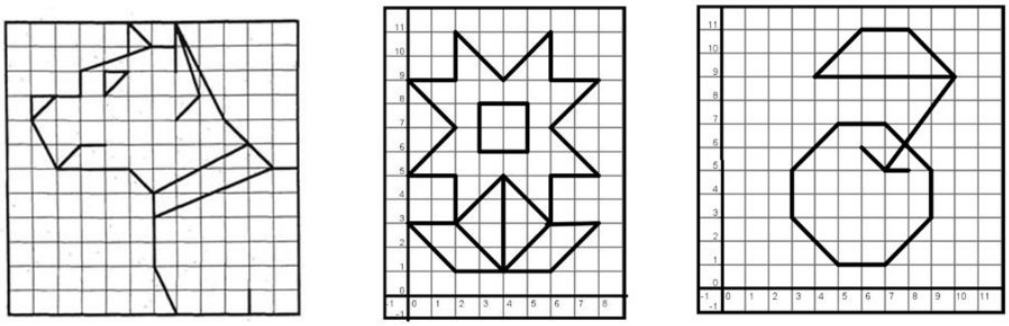
methods instead.
```



3. **Generar** los waypoints (puntos de referencia) necesarios para obtener las siguientes trayectorias, ajustando el tiempo de muestreo: **"sampleTime"**, vector de tiempo: **"tVec"**, pose inicial: **"initPose"**, y los waypoints: **"waypoints"**



Para este tercer punto, genere los waypoints para obtener las tres trayectorias de este punto. Como en el punto anterior, el vector de tiempo se obtuve de manera heursitica, pero a diferencia del punto anterior, use una velocidad lineal de 1 y una angular de 12, retomando lo mencionado anteriormente, la velocidad angular es mucho mayor a la lineal y se desvia menos de la trayectoria, y a pesar de que se aumento considerablemente la velocidad angular siguen estando esas curvas que se desvian un poco, pero esto es porque los waypoints son muy cercanos a diferencia de los ejercicios del punto anterior, entonces los giros deberían realizarse más rapido.

```
%% Define Vehicle
```

```
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.05;               % Sample time [s]
tVec = 0:sampleTime:85;         % Time array

initPose = [1;8;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [1,8; 2,9; 1,9; 1,8; 2,6; 3,7; 4,7; 3,7; 2,6; 5,6; 6,5; 6,4;
    11,6; 10,7; 6,5; 6,2; 7,0; 10,0; 10,1; 10,0; 12,0; 12,6; 11,6; 10,7;
    9,8; 7,12; 7,10; 7,8; 8,9; 7,12; 7,11; 6,11; 5,10.66; 5,12; 6,11; 3,10;
    4,10; 5,10; 4,9; 4,10; 3,10; 3,9; 2,9];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.2;
controller.DesiredLinearVelocity = 1;
controller.MaxAngularVelocity = 12;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);


    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);
```

```
end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
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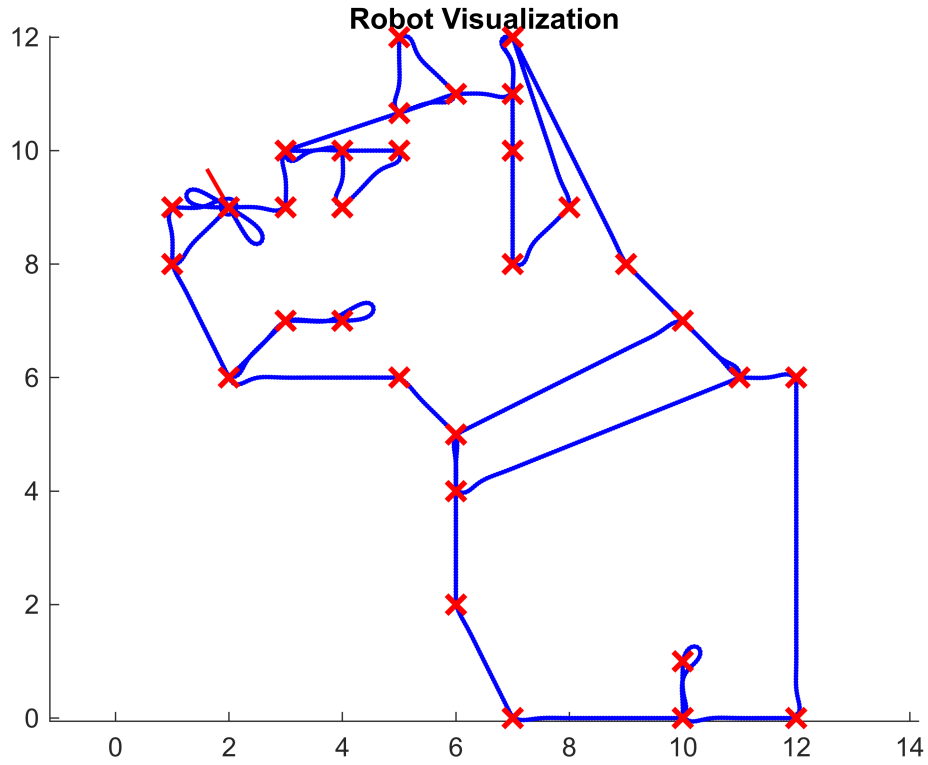


```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.05;               % Sample time [s]
tVec = 0:sampleTime:73;         % Time array

initPose = [4;5;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [4,5; 2,3; 4,1; 2,1; 0,3; 2,3; 2,5; 0,5; 2,7; 0,9; 2,9; 2,11;
    4,9; 6,11; 6,9; 8,9; 6,7; 8,5; 6,5; 6,3; 8,3; 6,1; 4,1; 6,3; 4,5; 4,6;
    3,6; 3,8; 5,8; 5,6; 4,6; 4,1];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;
```

```
%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
controller.LookaheadDistance = 0.2;
controller.DesiredLinearVelocity = 1;
controller.MaxAngularVelocity = 12;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);


    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);

end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
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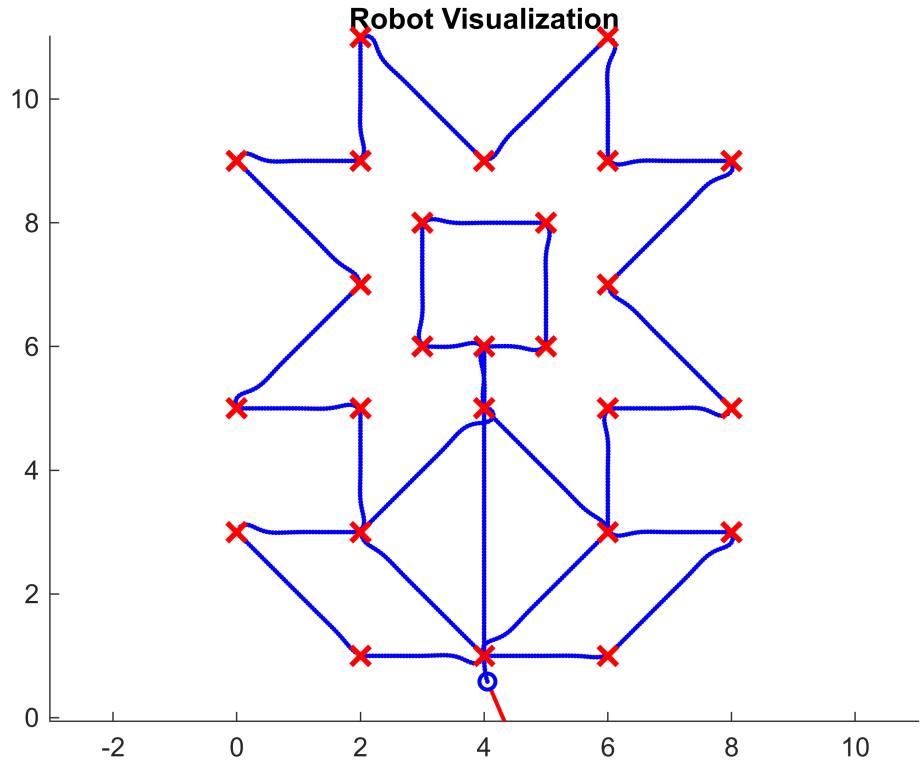
methods instead.
```




```
%% Define Vehicle
R = 0.1;                % Wheel radius [m]
L = 0.5;                % Wheelbase [m]
dd = DifferentialDrive(R,L);

%% Simulation parameters
sampleTime = 0.05;               % Sample time [s]
tVec = 0:sampleTime:48;         % Time array

initPose = [6;6;0];             % Initial pose (x y theta)
pose = zeros(3,numel(tVec));    % Pose matrix
pose(:,1) = initPose;

% Define waypoints
waypoints = [6,6; 7,5; 8,5; 7,5; 10,9; 4,9; 6,11; 8,11; 10,9; 7.8,5.9;
             7,7; 5,7; 3,5; 3,3; 5,1; 7,1; 9,3; 9,5; 7,7];

% Create visualizer
viz = Visualizer2D;
viz.hasWaypoints = true;

%% Pure Pursuit Controller
controller = controllerPurePursuit;
controller.Waypoints = waypoints;
```

```
controller.LookaheadDistance = 0.2;
controller.DesiredLinearVelocity = 1;
controller.MaxAngularVelocity = 12;

%% Simulation loop
%close all
r = rateControl(1/sampleTime);
for idx = 2:numel(tVec)
    % Run the Pure Pursuit controller and convert output to wheel speeds
    [vRef,wRef] = controller(pose(:,idx-1));
    [wL,wR] = inverseKinematics(dd,vRef,wRef);


    % Compute the velocities
    [v,w] = forwardKinematics(dd,wL,wR);
    velB = [v;0;w]; % Body velocities [vx;vy;w]
    vel = bodyToWorld(velB,pose(:,idx-1));  % Convert from body to world

    % Perform forward discrete integration step
    pose(:,idx) = pose(:,idx-1) + vel*sampleTime;

    % Update visualization
    viz(pose(:,idx),waypoints);
    waitfor(r);

end
```

```
Warning: System Object 'Visualizer2D' is inherited from mixin class 'matlab.system.mixin.CustomIcon' that
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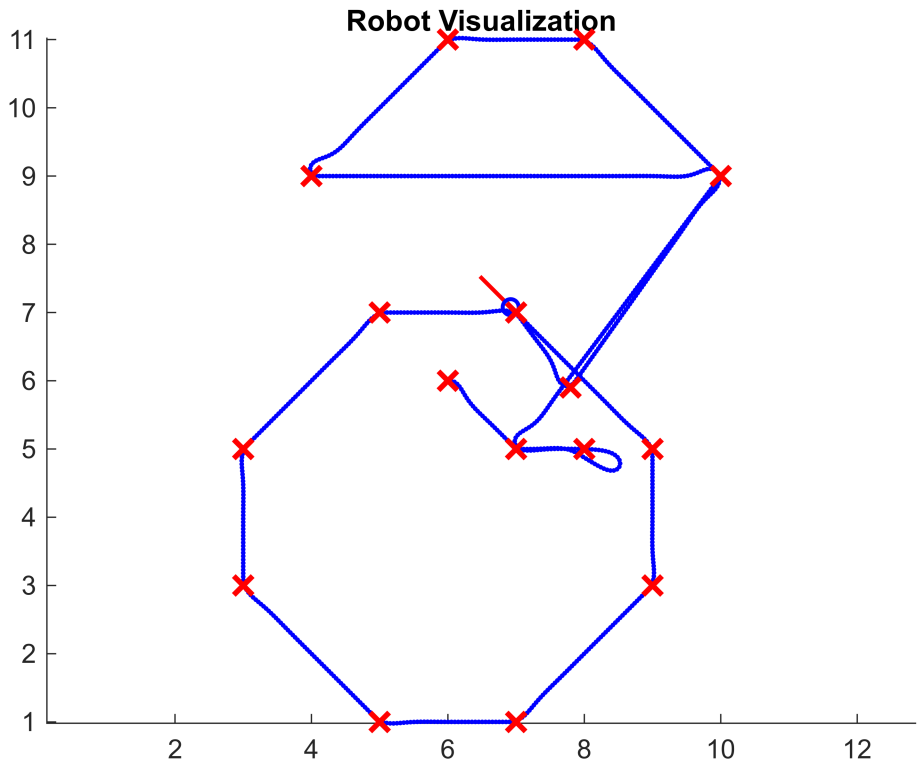
```


Robot Visualization
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